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Research Article

Unwanted guests: The first records of two established non-native moth species in the Caucasus, with notes on non-native fauna of Georgia

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Abstract

This study aims to expand our current knowledge of biological invasions of Georgia by reporting the first records of two non-native moth genera *Micromelalopha* Nagano, 1916 (Notodontidae), and *Antheraea* Hübner, 1819 (Saturniidae) from the South Caucasus, based on three male specimens of *Micromelalopha sieversi* (Staudinger, 1892) and five male specimens of *Antheraea pernyi* (Guérin-Méneville, 1855). These findings are based on recent field collections, supported by morphological examination and DNA barcoding, and contribute to a better understanding of the region's shifting lepidopteran fauna and potential bio-invasion risks. Additionally, we provide the first comprehensive list of non-native animal species recorded in Georgia, based on literary and online sources.

Key words: *Antheraea pernyi*, barcoding, Lepidoptera, *Micromelalopha sieversi*, new records, Notodontidae, Saturniidae, South Caucasus

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Introduction

Despite being well defined in a scientific context, the distinction between non-native, and invasive species is often misunderstood by the general public. A non-native species refers to any organism found outside its native range, typically as a result of human activity. In contrast, an invasive species is a subset of these non-native species that, once introduced to a new environment (with or without human mediation), becomes established and causes ecological and economic harm (Soto et al. 2024).

The South Caucasus region, and particularly the Black Sea coast of Georgia, has proved a conducive environment for introduced and invasive invertebrate species, largely due to its favourable climate. This influx has negatively impacted both the ecological balance and economic stability of the region. The earliest documented record of a non-native species in the region is *Samia cynthia* (Drury, 1773), a species native to East Asia, which was intentionally introduced to north-western Georgia in around 1860 for silk production; it subsequently established a local population in western Georgia (Zolotuhin et al. 2011). Another early documented case is the accidental introduction of the fall webworm, *Hy-*

phantria cunea (Drury, 1773) in 1976, most likely transported from Ukraine in infested wood material. A native of North America, it rapidly established itself and inflicted substantial harm on native flora (Japoshvili et al. 2006).

The present study contributes to the growing body of research on non-native and potentially invasive species in Georgia by reporting the first records of two Lepidopteran genera, *Micromelalopha* Nagano, 1916 (Notodontidae), and *Antheraea* Hübner, 1819 (Saturniidae) in the South Caucasus. These findings are based on recent specimen collections and supported by morphological analysis and DNA barcoding. The documentation of these genera marks a significant addition to the region's lepidopteran fauna and raises questions about their origin, potential impact, and future distribution.

Material and methods

The specimens were gathered either by attracting the moths to light or collecting them manually. Location (given in WGS84) and elevation data were obtained using a Garmin MAP 64s GPS. The examined material is kept in a private collection of the senior author (hereafter as JLGT). Specimen identification was carried out using both external morphological characters and DNA barcoding. For morphological identification we used keys by Wu and Fang (2003) and Wu (2017). The photographs of preserved specimens were taken with a Canon EOS 90D camera equipped with a Canon EF 60 mm f/2.8 Macro USM lens. The living Micromelalopha sieversi was photographed using a Canon EOS 5D Mark II camera with a Canon MP-E 65mm f/2.8 1–5x Macro Photo Lens mounted on a Novoflex Castel-L Focusing Rack. Digital images were then prepared in Zerene Stacker "focus stacking" software and Adobe Photoshop CS6 (version 13.0).

The barcoding of *M. sieversi* was carried out within the Wellcome Sanger Institute's BIOSCAN project (Hobern 2020), while *A. pernyi* was barcoded during the Caucasus Barcode of Life project (CaBOL) using the standardised protocol described in Seropian et al. (2023). The newly obtained Cytochrome oxidase subunit I (COI) sequences were compared with each other and checked against the BOLD Systems database (http://www.boldsystems.org/index.php), where they had been recently uploaded. Barcode Index Number (BIN) (Ratnasingham and Hebert 2013) for the sequenced taxa and their nearest neighbour in BOLD Systems are also given. For the calculation of sequence differentiation, we used *p*-distance as calculated in the BOLD Systems.

Results

In total, eight specimens (all males) were examined, they comprised two genera both of which represented the first records in the Caucasus. The list below is given in alphabetical order.

Family Notodontidae Stephens, 1829

Remarks. The Notodontidae (prominent moths) are medium-sized moths, usually with cryptic colouration. Many species have distinctive tufts or projections on the forewings, front legs, or thorax, which give the family its name. The family is most diverse in temperate regions, especially in forests. In the territory

of Georgia, it is represented by 35 species comprised in 18 genera (Georgian Biodiversity Database – hereafter GBD).

Genus *Micromelalopha* Nagano, 1916

Remarks. The genus comprises about 25 species, most of which occur in East Asia. They are distributed in China, Japan, Korea, Russia (Primorsky Krai), Afghanistan, India, Nepal, Vietnam, Philippines, Malaysia and Indonesia (Wu and Fang 2003). Until this study, no congeners have been recorded outside their native range. Several species of *Micromelalopha* e.g. *M. sieversi* (Staudinger, 1892), are considered as pests of *Populus* species within their native range (Dai et al. 2024).

***Micromelalopha sieversi* (Staudinger, 1892)**
Figs 1–2

Micromelalopha sieversi: Dai et al. 2024: 50, figs 1A–B (♂)

Material examined. Georgia • 2♂; Dighomi Massive, Tbilisi; 21 Jun. 2023; leg: A. Seropian; JLGT • 1♂; Sanzona, Tbilisi; 2 August 2025; leg. L-G. Japaridze; JLGT.

Diagnosis. For diagnosis, see Wu and Fang (2003).

Barcoding. We obtained a single sequence (BOLD:ACQ7797), identical to those of *M. sieversi* from China (BOLD:ACQ7797).

Remarks. In China, where this species originates, it is an important pest of poplar trees. Commonly, it occurs in 3–4 generations in north-east China, and in 5–7 generations in central and southern China (Dai et al. 2024). Specimens

Figure 1. *Micromelalopha sieversi*, male, Tbilisi (Dighomi massive), live specimen, not for scale.

collected in 2023 and 2025 confirm the establishment of a stable population of this species, at least in the capital of Georgia. So far, no substantial harm to local *Populus* spp. has been documented. It is the first record of the genus *Micromelalopha* in the Caucasus.

Family Saturniidae Boisduval, 1837

Remarks. Members of Saturniidae are medium to very large moths, usually with robust, hairy bodies and broad wings, often bearing conspicuous eyespots or transparent hyaline "windows." Antennae are bipectinate in both sexes, strongly so in males. The family is most diverse in tropical regions (Kitching et al. 2018). In the territory of Georgia, it is represented by seven species comprised in three genera, of which *Samia cynthia* (Drury, 1773) was intentionally introduced for silk production (Zolotuhin et al. 2011).

Genus *Antheraea* Hübner, 1919

Remarks. The genus is one of the most diverse within the family, comprising more than 100 species, most of which occur in tropics of East Asia and South America (Kitching et al. 2018). Several species, e.g., *A. pernyi* (Guérin-Méneville, 1855) and *A. yamamai* Guérin-Meneville, 1861 were introduced into Europe for silk production purposes (Pinya et al. 2013; Flajšman et al. 2019).

***Antheraea pernyi* (Guérin-Méneville, 1855)**
Fig. 3

Antheraea pernyi: Pinya et al. 2013: 377, fig. 1 (♂)

Material examined. GEORGIA • 2♂; Imereti, Baghdati; 6 May 2021; leg: G. Gorgodze; JLGT • 1♂ (CaBOL-ID 1021655); Ilemi; leg: T. Lomidze; 16 June 2021; JLGT • 1♂; Vartsikhe; leg: A. Babunashvili; 5 April 2024; JLGT • 1♂; Ajameti; leg: A. Bubunashvili; 29 April 2024; JLGT.

Diagnosis. For diagnosis, see Wu (2017).

Barcoding. We obtained a single sequence from the specimen CaBOL-ID 1021655 (BOLD:ABY5349), identical to those of *A. pernyi f*rom Russia (Siberia), India, North Korea, South Korea, and China (BOLD:ABY5349).

Remarks. Originally native to China, where it was domesticated for silk production, *A. pernyi* is also distributed across Mongolia, northern China, India, and Japan. The main food source for its larvae are *Quercus* species (Wang et al. 2023). In Europe, it was first introduced to France in the 19th century for its potential in silk production, following an epidemic that affected *Bombyx mori* (Linnaeus, 1758) in 1855. The species was subsequently introduced to Spain, initially in Navarra and Guipúzcoa (northern Spain) in 1875, and later in Barcelona and Castellón de la Plana (eastern Spain). It reached the Balearic Islands (Mallorca and Menorca) by the end of the 19th century. Today, its distribution in Europe is limited to the Balearic Islands and the province of Barcelona (Pinya et al. 2013). Specimens in our study collected in 2021 and 2024 confirm a stable, locally established population in Imereti, western Georgia; although so far, no substantial harm to local *Quercus* spp. has been documented. These are the first verified

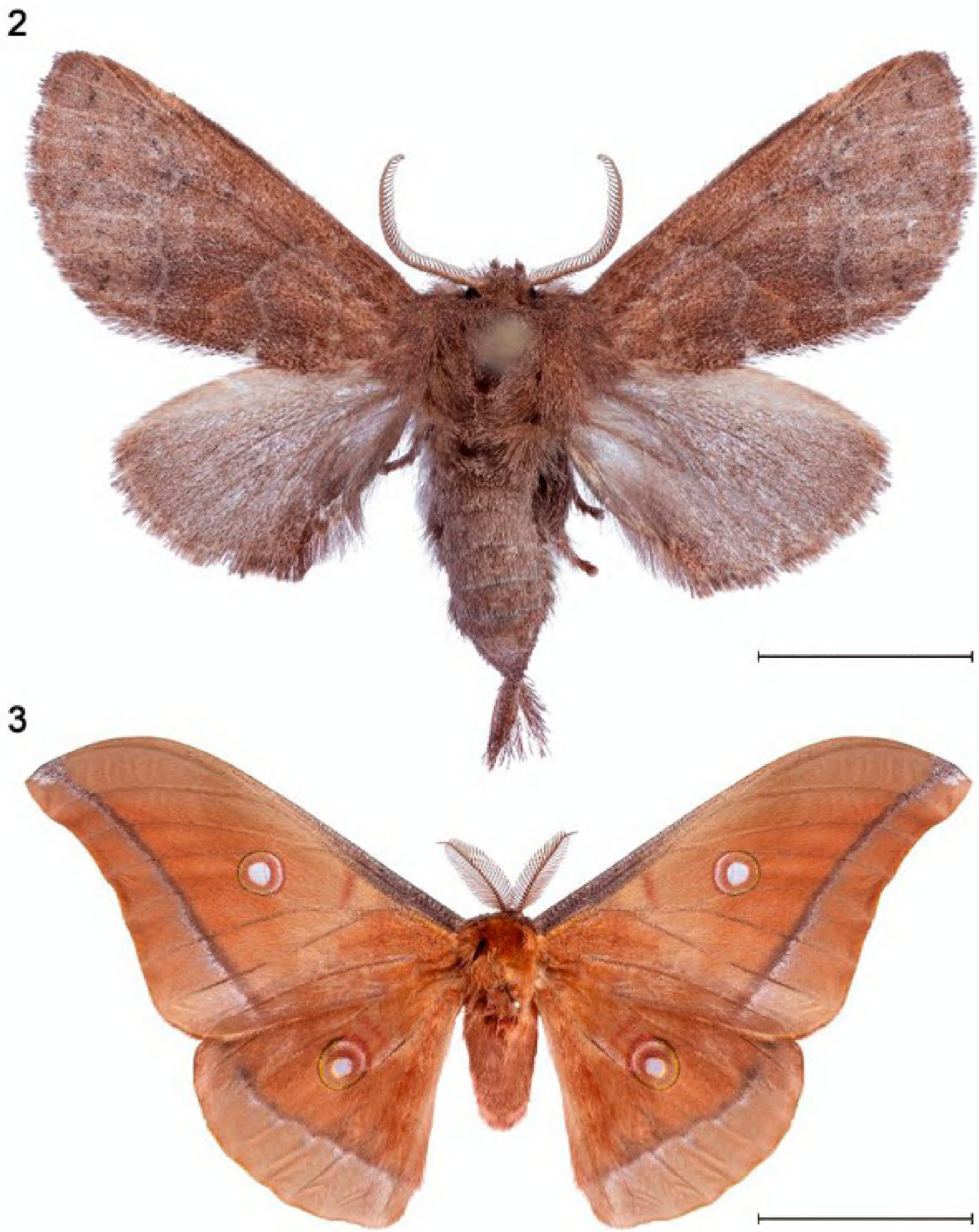

Figure 2–3. General habitus of (**2:** *Micromelalopha sieversi*, male, Tbilisi (Sanzona); **2:** *Antheraea pernyi* (CaBOL-ID 1021655), male. Baghdati). Scale bars: 5 mm (2); 35 mm (3).

records of the genus *Antheraea* in the Caucasus. As with *S. cynthia*, *A. pernyi* was probably introduced to the South Caucasus for silk production purposes, most likely during the 1930s under Soviet agricultural initiatives. Although the original introduction site is unknown, the *A. pernyi* population in Imereti probably originated from individuals that escaped silk farming facilities established in the past.

Discussion

Despite growing awareness, comprehensive data on non-native and invasive invertebrates in Georgia remain limited, underlining the need for systematic monitoring, early detection, and regional collaboration to assess and mitigate their impacts. In 2014, the box tree moth *Cydalima perspectalis* (Walker, 1859) was recorded for the first time in Georgia (Matsiakh 2016). Its larval feeding habits pose a serious threat to *Buxus colchica* Pojark, an endangered species listed in the Georgian Red List (Burjanadze et al. 2019). Non-native invasive species have not been limited to Lepidoptera or to land organisms - the brown marmorated stink bug *Halyomorpha halys* (Stål, 1855) became established in 2015 and has since become a major agricultural pest (Kharabadze 2022); the Asian rapa whelk *Rapana venosa* (Valenciennes, 1846), a native of the western Pacific, was first recorded in the Black Sea in 1946, possibly transported via ship ballast water, fouling or through oyster transports, now poses a major threat to local mollusc fauna (Bondarev 2014); the ctenophores, *Mnemiopsis leidyi* A. Agassiz, 1865 and *Beroe ovata* Bruguière, 1789, were introduced in the Black Sea in the late 1980s and 1990s respectively. *Mnemiopsis leidyi* caused severe ecological damage by preying on zooplankton, fish eggs, and larvae, leading to the collapse of several fish stocks. The subsequent arrival of *B. ovata*, a natural predator of *M. leidyi*, helped control its population. This predator-prey dynamic played a key role in partially restoring ecological balance in the Black Sea ecosystem (Mamish et al. 2020).

A notable trend among terrestrial biological invasions is the geographical origin of these species. The climate and ecological conditions of the South Caucasus region, particularly Georgia, appear highly favourable for the establishment of many East Asian species. This pattern presents substantial risks to native biodiversity, agriculture, and forest ecosystems.

In the absence of a comprehensive list of non-native animal species introduced to Georgia in the recent historical period, we have attempted to compile available data from published sources and platforms, such as iNaturalist (with “Research Grade” status) and GBD. A single observation of a non-native freshwater jellyfish (*Craspedacusta sowerbii*) Lankester, 1880 was kindly provided by the founder of EcoFilms, Nika Tsiklauri (hereafter - EcoFilms). The present list of non-native taxa consists of 134 species (see Table 1). It should be noted that this list is not exhaustive and is subject to continuous updates as new data become available.

Table 1. List of invasive/non-native animal species of Georgia

	Taxon name	Presence in Georgia according to:
	Chordata	
	Mammalia	
	Artiodactyla	
1	*Cervus nippon*	Bukhnikashvili and Kandaurov 2002
	Carnivora	
2	*Neogale vision*	Bukhnikashvili and Kandaurov 2002
3	*Nyctereutes procyonoides*	Bukhnikashvili and Kandaurov 2002
4	*Procyon lotor*	Bukhnikashvili and Kandaurov 2002

	Taxon name	Presence in Georgia according to:
	Rodentia	
5	*Hystrix indica*	Bukhnikashvili and Kandaurov 2002
6	*Myocastor coypus*	Bukhnikashvili and Kandaurov 2002
7	*Ondatra zibethicus*	Bukhnikashvili and Kandaurov 2002
8	*Sciurus vulgaris*	Bukhnikashvili and Kandaurov 2002
	Reptilia	
	Squamata	
9	*Phoenicolacerta laevis*	Tarkhnishvili et al. 2017
	Testudines	
10	*Trachemys scripta*	iNaturalist
	Pisces	
	Acanthuriformes	
11	*Sarpa salpa*	Varshanidze et al. 2022
12	*Sparus aurata*	Varshanidze et al. 2022
	Blenniiformes	
13	*Parablennius incognitus*	Varshanidze et al. 2022
	Cichliformes	
14	*Oreochromis niloticus*	Kuljanishvili et al. 2021a
	Clupeiformis	
18	*Sardinella aurita*	Varshanidze et al. 2022
	Cypriniformes	
16	*Carassius gibelio*	Kuljanishvili et al. 2021b
17	*Ctenopharyngodon idella*	Kuljanishvili et al. 2021b
18	*Cyprinus carpio*	Epitashvili et al. 2025
19	*Gobio artvinicus*	Kuljanishvili et al. 2021b
20	*Gobio caucasicus*	Epitashvili et al. 2025
21	*Hemiculter leucisculus*	Epitashvili et al. 2025
22	*Hypophthalmichthys molitrix*	Kuljanishvili et al. 2021b
23	*Hypophthalmichthys nobilis*	Kuljanishvili et al. 2021b
24	*Pseudorasbora parva*	Kuljanishvili et al. 2021b
	Cyprinodontiformes	
25	*Gambusia holbrooki*	Kuljanishvili et al. 2021b
	Esociformes	
26	*Esox lucius*	Kuljanishvili et al. 2020
	Eupercaria/misc	
27	*Lithognathus mormyrus*	Varshanidze et al. 2022
28	*Morone saxatilis*	Varshanidze et al. 2022
	Gobiiformes	
29	*Gobius xanthocephalus*	Varshanidze et al. 2022
30	*Neogobius fluviatilis*	Epitashvili et al. 2025
31	*Pomatoschistus bathi*	Varshanidze et al. 2022
32	*Rhinogobius lindbergi*	Kuljanishvili et al. 2021b
	Mugiliformes	
33	*Planiliza haematocheilus*	Varshanidze et al. 2022
	Perciformes	
34	*Gymnocephalus cernua*	Kuljanishvili et al. 2021b
35	*Perca fluviatilis*	Kuljanishvili et al. 2021b
36	*Sander lucioperca*	Epitashvili et al. 2025
	Salmoniformes	
37	*Coregonus albula*	Kuljanishvili et al. 2021b
38	*Oncorhynchus mykiss*	Kuljanishvili et al. 2021b
39	*Salmo gegarkuni*	Kuljanishvili et al. 2021b
	Siluriformes	
40	*Silurus glanis*	Epitashvili et al. 2025
	Syngnathiformes	

	Taxon name	Presence in Georgia according to:
41	*Syngnathus abaster*	Kuljanishvili et al. 2021b
	Invertebrata	
	Arthropoda	
	Arachnida	
	Araneae	
42	*Theridula gonygaster*	Mcheidze 1997
	Copepoda	
	Calanoida	
43	*Acartia tonsa*	Varshanidze et al. 2022
	Cyclopoida	
44	*Oithona davisae*	Varshanidze et al. 2022
	Diplopoda	
	Polydesmida	
45	*Oxidus gracilis*	Kokhia and Golovatch 2020
	Malacostraca	
	Amphipoda	
46	*Melita nitida*	Copilaș-Ciocianu et al. 2020
	Decapoda	
47	*Callinectes sapidus*	Shaverdashvili and Ninua 1975
48	*Macrobrachium nipponense*	Macrobrachium nipponense. Georgian Biodiversity Database
49	*Penaeus semisulcatus*	Guchmanidze et al. 2016
50	*Pontastacus leptodactylus*	Blaha et al. 2021
51	*Rhithropanopeus harrisii*	Japoshvili et al. 2020
	Thecostraca	
	Balanomorpha	
52	*Amphibalanus eburneus*	Varshanidze et al. 2022
53	*Amphibalanus improvisus*	Varshanidze et al. 2022
	Coleoptera	
54	*Acanthoscelides obtectus*	Orlova-Bienkowskaja 2019
55	*Bruchidius siliquastri*	Orlova-Bienkowskaja 2019
56	*Bruchidius terrenus*	Orlova-Bienkowskaja 2019
57	*Callidiellum rufipenne*	Orlova-Bienkowskaja 2019
58	*Cercyon laminatus*	Orlova-Bienkowskaja 2019
59	*Cryptolaemus montrouzieri*	Migeon and Arabuli 2022
60	*Cryptopleurum subtile*	Orlova-Bienkowskaja 2019
61	*Dendroctonus micans*	Kobakhidze 1965
62	*Epitrix hirtipennis*	Orlova-Bienkowskaja 2019
63	*Epuraea ocularis*	Tsinkevich and Solodnikov 2024
64	*Harmonia axyridis*	Migeon and Arabuli 2022
65	*Lamprodila festiva*	iNaturalist
66	*Leptinotarsa decemlineata*	Seperteladze et al. 1985
67	*Litargus balteatus*	Orlova-Bienkowskaja 2019
68	*Lyctus brunneus*	Orlova-Bienkowskaja 2019
69	*Maladera castanea*	Nikolajev 2002
70	*Megabruchidius dorsalis*	Orlova-Bienkowskaja 2019
71	*Naupactus cervinus*	Orlova-Bienkowskaja 2019
72	*Rhizophagus grandis*	Kobakhidze 1965
73	*Rhynchophorus ferrugineus*	Orlova-Bienkowskaja 2019
74	*Rhyzobius lophanthae*	Migeon and Arabuli 2022
75	*Rodolia cardinalis*	Migeon and Arabuli 2022
76	*Serangium montazerii*	Orlova-Bienkowskaja 2019
77	*Stelidota geminata*	Tsinkevich and Solodnikov 2024
78	*Xanthogaleruca luteola*	Shengelia 1951
79	*Xylosandrus germanus*	Orlova-Bienkowskaja 2019

	Taxon name	Presence in Georgia according to:
80	*Zygogramma suturalis*	Orlova-Bienkowskaja 2019
	Diptera	
81	*Drosophila suzukii*	Japoshvili et al. 2018
82	*Hermetia illucens*	iNaturalist
83	*Obolodiplosis robiniae*	Skuhravá et al.2013
84	*Trichopoda pictipennis*	iNaturalist
	Hemiptera	
85	*Aphis forbesi*	Jibladze 1975
86	*Ceroplastes japonicas*	Batiashvili and Dekanoidze 1974
87	*Corythucha arcuata*	Shchurov et al. 2019
88	*Corythucha ciliata*	Supatashvili et al. 2016
89	*Daktulosphaira vitifoliae*	Jibladze 1975
90	*Dialeurodes citri*	Batiashvili and Dekanoidze 1974
91	*Eriosoma lanigerum*	Batiashvili and Dekanoidze 1974
92	*Halyomorpha halys*	Kharabadze 2022
93	*Icerya purchasi*	Kobakhidze 1965
94	*Leptoglossus occidentalis*	van der Heyden 2018
95	*Lopholeucaspis japonica*	Batiashvili and Dekanoidze 1974
96	*Metcalfa pruinosa*	iNaturalist
97	*Orosanga japonica*	Akiner et al. 2022
98	*Pseudococcus calceolariae*	Kobakhidze 1965
99	*Stictocephala bisonia*	Ruchin et al. 2023
	Hymenoptera	
100	*Aphelinus mali*	Kobakhidze 1965
101	*Microterys clauseni*	Yasnosh and Japoshvili 1998
102	*Scutellista caerulea*	Batiashvili and Dekanoidze 1974
	Lepidoptera	
103	*Antheraea pernyi*	Present study
104	*Cameraria ohridella*	Didmanidze et al. 2010
105	*Cydalima perspectalis*	Matsiakh 2016
106	*Haritalodes derogata*	iNaturalist
107	*Haplochrois theae*	Lopez-Vaamonde et al. 2010
108	*Hyphantria cunea*	Japoshvili et al. 2006
109	*Glyphodes pyloalis*	Kanchaveli et al. 2009
110	*Micromelalopha sieversi*	Present study
111	*Paysandisia archon*	Mori et al. 2022
112	*Phthorimaea operculella*	Aleksidze 2014
113	*Phyllonorycter platani*	Martynov and Nikulina 2018
114	*Plodia interpunctella*	Zaguliaev 1981
115	*Samia cynthia*	Zolotuhin et al. 2011
116	*Tuta absoluta*	Khositashvili and Khositasvili 2021
	Orthoptera	
117	*Svistella bifasciata*	iNaturalist
118	*Velarifictorus micado*	Mulder and Gorochov 2019
	Psocoptera	
119	*Dorypteryx domestica*	Seropian et al. 2023
	Annelida	
	Polychaeta	
	Phyllodocida	
120	*Sigambra tentaculata*	Varshanidze et al. 2022
	Sabellida	
121	*Ficopomatus enigmaticus*	Varshanidze et al. 2022
	Spionida	
122	*Dipolydora quadrilobata*	Varshanidze et al. 2022
123	*Polydora ciliata*	Surugui 2005

	Taxon name	Presence in Georgia according to:
	Mollusca	
	Bivalvia	
	Arcida	
124	*Anadara kagoshimensis*	Varshanidze et al. 2022
	Myida	
125	*Mya arenaria*	Varshanidze et al. 2022
126	*Mytilopsis leucophaeata*	Mumladze et al. 2019
	Venerida	
127	*Corbicula fluminalis*	Mumladze et al. 2019
	Gastropoda	
	Hygrophila	
	Physidae	
128	*Physella acuta*	Mumladze et al. 2019
	Lymnaeoidea	
	Planorbidae	
129	*Ferrissia californica*	Mumladze et al. 2019
	Neogastropoda	
130	*Rapana venosa*	Bondarev 2014
	Stylommatophora	
131	*Eobania vermiculata*	Mumladze et al. 2019
	Cnidaria	
	Hydrozoa	
	Limnomedusae	
132	*Craspedacusta sowerbii*	EcoFilms
	Ctenophora	
	Nuda	
	Beroida	
133	*Beroe ovata*	Mamish et al. 2020
	Tentaculata	
	Lobata	
134	*Mnemiopsis leidyi*	Mamish et al. 2020

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Additional information

Conflict of interest

The authors have declared that no competing interests exist.

Ethical statement

No ethical statement was reported.

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Author contributions

Conceptualisation (L-GJ), original draft writing (L-GJ, AS), material collection (L-GJ, AS), visualisation (AS), data curation (L-GJ, AS).

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Data availability

All of the data that support the findings of this study are available in the main text or Supplementary Information.

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